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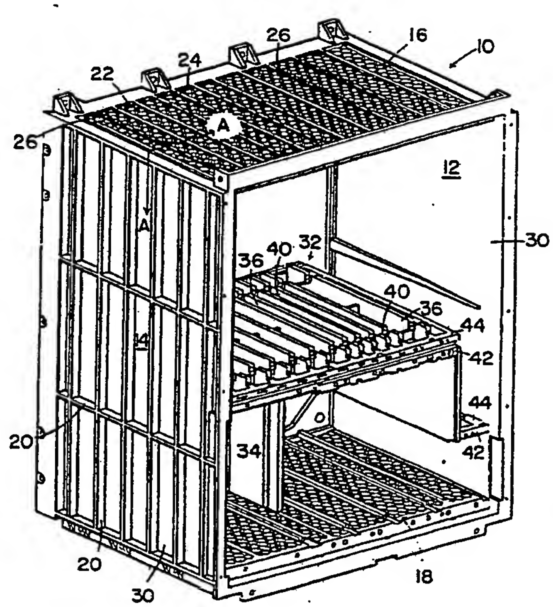
(54) Title: STRUCTURAL FRAMES FOR ELECTRICALLY SHIELDED ENCLOSURES

(57) Abstract

A single piece, seamless structural frame comprising oppositely disposed end members connected by side walls. Each end member is comprised of a honeycomb array of apertures. An electrically conductive coating extends over the interior and exterior surfaces of the side walls and end members including the aperture walls. The frame can be constructed from a plastics based material using a low pressure structural foam molding process and the electrically conductive coating may be a two-layer electroless plated coating of copper and nickel. Alternatively, a plastics based material incorporating a conductive filler may be used with a limited width band of electrically conductive material around a peripheral surface area of the frame. The frame has particular utility as a card cage enclosure for printed circuit cards and associated power supply units in a computer system. The seamless frame enhances attenuation shielding against EMI/RFI radiation from the components within the container while allowing coolant air flow to move through registers defined by the end wall apertures.



STRUCTURAL FRAMES FOR ELECTRICALLY SHIELDED ENCLOSURES

BACKGROUND OF THE INVENTION

This invention relates to structural frames, in particular for use in electrically shielded enclosures for housing electronic components in computer systems.

Present day computer systems employ complex electronic circuits utilizing microprocessor, logic and memory integrated circuits. Operation of these circuits is controlled by one or more clock generators which produce levels of Electromagnetic interference/Radio frequency interference (EMI/RFI) radiation. Typically, these circuits are assembled on printed circuit module cards which, together with power supply units, are housed in a common card cage enclosure.

As the operating speeds of state of the art microprocessors increase, so do the frequencies of the clock generators. Consequently, the levels of EMI/RFI (noise) radiation from the circuits increase. One requirement of a card cage enclosure design is to provide adequate shielding attenuation to reduce EMI/RFI radiation externally of the cage to acceptable levels. The power level of EMI/RFI radiation increases non-linearly with the source frequency so that the shielding attenuation capability required of the card cage enclosure increases dramatically with increasing clock frequencies. Another design requirement is to provide adequate cooling within the enclosure. The power supply units incorporated in the card cage enclosure generate heat, and

cooling is typically effected by forced air flow through registers in the enclosure walls. As the power requirements and packaging densities of the electronic circuits and power capacity of the power supply units increase, higher rates and volumes of air flow are required to provide adequate cooling. These factors combine to increase the performance demands placed on the card cage enclosure design in order to comply with increasingly stringent industry standards. For example, one relevant standard, IEEE 896.2 requires that such enclosures provide EMI/RFI shielding attenuation of at least 20db at 5Ghz and airflow of at least 300 Linear Feet per Minute.

In the past, some card cage enclosure designs have employed sheet metal panels which were apertured to provide air flow registers, while in other designs metal plated plastic panels have been substituted for some of the metal panels. These structures have typically been constructed from several piece parts with gasketed seams at each panel interface to reduce EMI/RFI radiation leakage. As greater attenuation of EMI/RFI radiation mandated by higher frequency devices has been required, these types of enclosures have become functionally less effective, and their assembly as multi-piece structures - especially in terms of ensuring the integrity of gasketed interfaces - has become far more costly and critical.

BRIEF SUMMARY OF THE INVENTION

The present invention provides a structural support member comprising oppositely disposed edge walls joined by side walls and opposed end members to form a physically continuous, single-piece support frame having opposed end openings bounded by said edge walls and end members. Spaced apart apertures are defined in each end member by through walls extending through the thickness of that end member. The end members and the side walls have a continuous

electrical path extending around substantially the whole perimeter area of the frame. The electrical path includes an electrically conductive, peripheral surface band extending over at least part of a surface area of each of the end members and the side walls.

The frame may be electrically non-conductive or electrically conductive and suitably may be constructed using a plastics based material. In one embodiment, the plastics material may be electrically non-conductive and the electrical path and the electrically conductive band may be provided by a common coating over surface areas of the side walls and end members of the frame, including the through-walls defining the apertures in the end members.

Alternatively, the plastics-based material may incorporate an electrically conductive filler and the electrically conductive band may be an electrically conductive surface coating defining a band extending around the perimeter of the frame but occupying only part of the surface area of the frame. The electrically conductive band may be restricted to a margin area of the end members and the side walls adjacent to one of the end openings in the frame.

In a preferred embodiment of the invention, a single piece structural frame for a container has oppositely disposed end members joined by side walls. The end members have spaced apart apertures defined by through walls in each end member. The container is composed of plastics based structural support material having a substantially continuous coating of electrically conductive material extending over the surface areas of the side walls and end members including the through walls defining the apertures. Preferably, the electrically conductive coating extends over both the internal and external surface areas of the frame but for some

applications, coverage of only the internal or of only the external surface areas could be adequate.

In a particular embodiment of the invention, particularly suited for employment in a computer card cage enclosure as referred to above, the single piece container frame has continuous peripheral walls defining a rectangle. An opposed pair of the peripheral walls each incorporates a honeycomb array of openings separated by interconnected through-walls. The peripheral walls comprise a single plastics material member providing structural support, with electrically conductive material forming a continuous coating adhered to and extending completely over the peripheral wall surfaces and over the through-walls that define the apertures, to provide both the electrically conductive path and the peripheral surface band referred to above.

Preferably, the frame is a structural foam injection molded single piece unit made from a polymeric based material having a high flexural modulus, for example at least $1x10^6$ p.s.i., to provide structural stability and rigidity. This unit is covered with continuous, electroless plated nickel on copper surface coatings, the outer nickel coating providing a wear resistant coating.

Both technical and economic advantages arise from the invention. For example, container frames can be constructed that have enhanced structural stability and rigidity as compared with multiple piece assemblies and without high weight penalties. Such frames have particular utility in constructing card cage enclosures for computers, accommodating printed circuit module cards providing clocked logic, memory and other electronic functions, as well as accommodating power supplies. A single-piece, physically continuous plastics structural frame incorporating a

continuous, electrically conductive path eliminates radiation leakage paths. In this manner, only interface leakage associated with accommodation of panels in the front and rear openings of the frame needs to be addressed. In this respect the electrically conductive, peripheral surface band provides an integral surface to which RF shielding gaskets can make reliable contact for minimal radiation leakage.

The honeycomb apertures in the end members can be dimensioned and formed to balance requirements for functionality as an effective EMI/RFI radiation attenuation shield as well as enhancing the available air flow area for cooling of electronic circuits and their power supplies housed in the cage enclosure. As a result, a card cage enclosure embodying the invention can be constructed to provide high level performance shielding attenuation against EMI/RFI radiation resulting from operation of the electronic circuits at high frequencies. At the current state of the art, this may require EMI/RFI shielding to be effective at frequencies extending at least to several gigahertz. Also, sufficient aperture area can be provided to enable slower speed air movers to be used resulting in reduced levels of acoustic noise than in comparable prior art structures. The structural frame can be cost effectively manufactured and strict manufacturing tolerances can be reliably achieved on a repetitive basis using a low pressure, structural foam molding process employing a high flexural modulus, polymeric based plastics material.

BRIEF DESCRIPTION OF THE DRAWINGS

By way of example, embodiments of the invention will be described in greater detail with reference to the drawings, in which:

FIGURE 1 is a perspective view of a container structural frame embodying the invention;

FIGURE 2 is a cross-section along the line A-A at the corner between the top end member and the left side wall of the structural frame shown in FIGURE 1;

FIGURE 3 is an enlarged plan view of part of one end member of the structural frame shown in FIGURE 1, illustrating the honeycomb structure;

FIGURE 4 is a cross-section along the line B-B in FIGURE 5;

FIGURE 5 is a rear elevation of the structural frame shown in FIGURE 1;

FIGURE 6 is a front elevation of the structural frame shown in FIGURE 1 with a back-plane inserted in the rear opening of the frame;

FIGURE 7 is a rear view of the structural frame shown in FIGURE 1 with a metal backing shield in place;

FIGURE 8 is a cross-section along the line C-C in FIGURE 7;

FIGURE 9 is a front elevation of the structural frame shown in FIGURE 1 accommodating various module cards and power supply units to form a card cage enclosure; and

FIGURE 10 is a detail view of the circled portion of FIGURE 9;

FIGURE 11 is a perspective view of a frame embodying a different aspect of the invention; and

FIGURE 12 is a section along the line D-D in FIGURE 11.

DETAILED DESCRIPTION OF INVENTION

FIGURES 1-5 show a structural frame for receiving various functional module printed circuit cards, power supply units and a back plane as illustrated by FIGURES 6-9 to provide a card cage enclosure system for use in a computer system. The overall enclosure system shields against EMI/RFI (noise) radiation from components housed in the enclosure system while having apertured end members permitting air flow through the interior of the enclosure for cooling purposes.

The structural frame 10 has peripheral walls formed by a pair of opposed side walls 12, 14 joined by a pair of opposed end wall members 16, 18 which together form a rectangular frame having open front and back ends. The walls 12, 14, 16, and 18 are physically continuous with each other so that an integral, seamless, single-piece structural frame is defined.

The side walls 12, 14 have lengthwise and widthwise reinforcing members 20 and at the edges the frame has various mounting flanges and brackets.

As better shown in FIGURES 3 and 4, the end member 16 comprises a patterned array of apertures 22, predominantly hexagonal shaped, separated by interconnected walls 24 of substantially uniform thicknesses, extending through the thickness of the end member 16 to form a honeycomb patterned array. The honeycomb array is divided into rectangular sections by ribs 26 extending between the open faces of the frame 10. Adjacent to the ribs 26, the end member apertures are shaped as part hexagons. On the interior of the frame, the ribs of the end member 16 are formed as guide tracks 28 for accommodating printed circuit module cards. The end member 18 has a similar structure except that only some of the ribs 26 provide guide tracks 28 on the interior of the frame.

The structural frame 10 thus far described is preferably manufactured using a statistically controlled, low pressure structural foam molding process in which a plastics based resin compound together with a blowing (foaming) agent is introduced into an injection mold through multiple gates. Within the injection mold, the plastic resin flows along multiple runners positioned and dimensioned to ensure uniform flow of the plastic resin during its passage through the mold to avoid undesirable stresses in the completed structure which could lead to distortion of the structure during subsequent plating processes as well as compromising the adhesion of the plating itself. Some of the runners are positioned to result in formation of the portions of the ribs 26 on the exterior of the frame.

The preferred molding compound is a polymeric based material comprising about 70% polyphenolene oxide and about 30% filler, suitably 20% glass fibre and 10% mica, such as FM3020 Foam Resin supplied under the Registered Trademark "NORYL" by General Electric Company, One Plastics Avenue, Pittsfield, MA 01201. The preferred blowing agent for this resin is also supplied by General Electric Company under the designation FNC-020.

In this manner, rigid structural frames can be produced repeatedly having tightly controlled dimensions. Also, the process enables frames having larger overall dimensions and thicker walls to be more reliably obtained than is possible using a solid wall injection molding process. In addition, a required thickness of the end members 16,18 can be obtained together with thin (relative to the end member thickness) aperture walls 24 of substantially uniform thickness to provide both the required EMI/RFI shielding attenuation (when provided with an electrically conductive coating as described

below) as well as accommodating the required cooling air flow. Because of use of structural foam injection molding, the aperture walls 24 are slightly tapered to facilitate mold extraction and "uniform thickness" is to be understood in this context.

A continuous electrically conductive layer 30 extends completely over and adherently to all internal and external surfaces of the side walls 12, 14 and the end members 16,18 including the side-walls 24 of the honeycomb apertures 22, as best illustrated in FIGURES 2 and 4 showing the layer 30 with an exaggerated thickness. The conductive layer provides a continuous electrical path extending around the whole perimeter area of the frame. The layer 30 comprises an underlayer of copper providing suitably high conductivity and an overlayer of nickel for durability and wear (abrasion) resistance. The conductive layer 30 is formed by initially etching the plastics material of the frame 10 using chromic acid and forming thereon a copper layer by an electroless plating process. Again using an electroless plating process, a layer of nickel is deposited over the copper layer.

In use of the structural frame so far described in construction of a card cage enclosure, a shelf 32 is located between and secured to the side walls 12, 14 within the frame 10 and a support member 34 is located between the lower end member 18 and the underside of the shelf 32. The shelf 32 incorporates integral, spaced apart, upstanding guideways 36 and dependent guideways 38 extending from the front to the back of the frame 10. The guideways 36 and 38 define tracks 40 which align with the tracks 28 provided in the end members 16 and 18, for receiving printed circuit module cards or other functional modules to be housed by the card cage enclosure.

The shelf 32 is fabricated using a low pressure, structural foam injection molding process as described above with reference to fabrication of the frame 10. The front edge 42 and front margins 44 of the shelf are also coated with a Cu/Ni layer using electroless plating processes as described above to maintain EMI shield integrity when modules are inserted into the frame 10 as explained below.

The rear opening (as seen in FIGURE 1) of the frame 10 accommodates a back plane 46 incorporating various electrical connectors 47A shown in FIGURE 6. The back plane 46 is enclosed within a dished metal shielding plate 48 closing the rear opening on the exterior of the frame 10 as shown in FIGURES 7 and 8. The shielding plate 48 has a perimeter wall 50 projecting perpendicularly from the surface of the metal plate 48 towards the rear edge of the frame 10. The perimeter wall 50 is located in a rectangular peripheral groove in the rear edge of the frame 10. Located in the groove is a continuous, electrically conductive, annular, wire mesh tubular gasket 52 having a diameter slightly greater that the width of the groove. The shield plate 48 is secured to the frame 10 by screws so that the edges of the perimeter wall 50 engage with and compress the tubular gasket 52 to provide an electrically continuous path with the conductive coating 30 along the whole perimeter of the shield plate 48.

Referring to FIGURE 9, functional modules FM comprising printed circuit cards (for example comprising clocked logic and memory cards) are inserted into the tracks 40 and the aligned tracks in the end member 16. The printed circuit cards have electrical connectors which mate with corresponding ones of the connectors 47 in the back plane 46. Each module FM also has an electrically conductive, rectangular outer end panel 54 the left hand sides and top and bottom edges of which incorporate RF shielding gasket

edge strips 56, the detail of which is shown in FIGURE 10, comprising resilient, electrically conductive fingers 58 which engage with the conductive end panels 54 of adjacent modules as well as with the conductive coatings on the front edge margins 44 of the shelf 32 and with the conductive coating 30 on the top edge of the frame 10. The right hand most rectangular outer end panel 54 in addition incorporates end panel edge strips 56, on the right hand edge, making contact with the conductive coating 30 on the side wall 12.

Power supply units PS are accommodated by the tracks 40 in the end member 18 and beneath the shelf 32. The power supply units also have electrical connectors which mate with corresponding electrical connectors 47B incorporated in the back plane 46 which are connected to the connectors 47A for supply of power to the modules FM. Also, the power supply units have electrically conductive front panels 62 and RF shielding gasket edge strips 56 attached to their left hand, upper and lower edges which engage with the conductive front panels 62 of adjacent modules, with the conductive coating 30 on the left hand and bottom edge margins of the frame 10, and with the conductive coating at the edge margins 42,44 of the shelf 32. At the lower right and left hand sides of the frame, the outermost conductive panels 62 engage in electrical contact with edge strips 60 contacting the conductive coating 30 of the side walls 12 and 14. In the event one or more of the tracks 40 does not accommodate a module, a closure panel CS comprising an electrically conductive end panel 54 having an RF shielding gasket edge strip 56 as described above is inserted in each empty track.

The RF shielding gasket edge strips at the top and bottom edges of all end panels 54,62 are located between those end panels and the edge surfaces of the peripheral walls 12,14,16,18 and of the shelf 32, in the manner indicated by

phantom outline in FIGURE 10.

In this manner, the conductive end panels of the modules FM, closure strips CS, and power supply units PS, in conjunction with the RF shielding gasket edge strips, provide an electrically continuous closure surface at the front of the frame 10, extending between and connected to the conductive layer 30 on the side walls 12,14 and the end members 16,18 as well as to the conductive layers on the edge margins 42,44 on the shelf 32.

The edge strips 56 provided on the sides of the modules FM, closure panels CS, and power supply units PS suitably are Type 97-957 RF shielding gaskets, while those on the top and bottom edges are Type 97-210 RF shielding gaskets. The edge strips 60 attached to the edges of the wall 12 of the structural frame 10 are suitably Type 97-631 RF shielding gaskets. These gaskets are supplied by Instrument Speciality Co., Inc., Delaware Water Gap, PA 18347-0136 and described in that company's publication "RF Shielding Selection" CAT-91.

Thus, the frame 10 has an electrically continuous inner and outer surface area which is physically seamless. The front opening of the frame is closed by the functional modules FM, closure panels CS, and the power supply units PS which cooperate to provide a surface over which electrical discontinuities are minimized by the RF shielding gasket edge strips on the modules FM, power supply units PS and the conductive margins of the frame 10 and shelf 32. The rear opening of the frame 10 is closed by the metal shield 48 which is electrically connected through the tubular wire mesh gasket 52 to the conductive coating 30 on the frame 10 completely around the perimeter of the metal shield. Thus, electrical discontinuities are avoided around the whole

surface area of the frame 10 and minimized over the front and rear surfaces as well as around their perimeter interface with the edges of the frame 10, thus providing, with respect to EMI/RFI radiation, an essentially electrically continuous surface over all of the surface areas of the card cage enclosure, which minimizes EMI/RFI leakage.

In a particular embodiment of the invention, a structural frame 10 has overall external dimensions of height H = 57.0 cms.; width W = 44.5 cms. and depth D = 33.3 cms.; the thickness of the sidewalls 12, 14 is T = 0.635cms. The end members 16,18 have a thickness (and hence an aperture length) of 1.0 cm while the nominal thickness of the aperture sidewalls 24 is t = 0.2 mm. The apertures 22 are dimensioned to have a maximum point-to-point width S = 1.0 cms.

The overall thickness of the copper/nickel conductive layer 30 is suitably 127X10-6mm (50 x 10^{-6}) inch with the copper layer thickness being about 102X10-6mm (40 x 10^{-6} inch).

The frame comprising the plastics structural support member with electrically conductive coated interior and exterior surfaces can be cost effectively manufactured with a high degree of dimensional stability and provides a high strength, rigid yet lightweight structure. When used to fabricate a card cage enclosure, housing electronic components that generate significant EMI/RFI radiation, for example clocked computer logic circuits, effective EMI/RFI shielding attenuation can be obtained even at high frequencies in the gigahertz range. The apertured end members 16, 18 permit this efficacy to be obtained because of the fabrication of those end members with a relatively large thickness T (which determines the aperture lengths) and aperture cross sections dimensioned such that at the EMI/RFI frequencies of interest, an effectively electrically continuous shielding

surface is provided. At the same time, maintaining a relatively thin aperture side wall thickness maximizes the apertured area that can be provided to permit adequate coolant air flow over the functional modules and power supply units housed within the container, provided by air movers that operate with acceptable acoustic noise levels.

In a structural frame embodying the invention as thus far described, the polyphenolene oxide material preferably incorporates from about 10-30% filler. Glass filler is preferred in order to obtain dimensional stability and rigidity and this is materially assisted by incorporation of mica in the filler to minimize orientation of the glass fibers. Embodiments of the invention could be constructed using alternative materials than those discussed in the preceding description. For example, a polycarbonate based plastics material, suitably incorporating about 30% glass filler could be used instead of a polyphenolene oxide based material. Graphite could be used in place of glass as a filler material in some applications. Although less preferable, for some applications the conductive coating could be provided by use of conductive spray paint (e.g. copper acrylic spray paint) or by vacuum deposition, e.g. of aluminum.

In the above described embodiment of the invention, the structural frame has been described with reference to a plastics based material which is electrically non-conductive. However, its also possible to construct the structural frame using an electrically conductive material. In one example, a plastics based material incorporating an electrically conductive material could be used. FIGURES 11 and 12 show a structural frame similar to that depicted in FIGURE 1. However, in FIGURES 11 and 12 the side walls 12, 14 and the end members 16,18 which comprise the structural frame 10A are

formed using a molded plastics material incorporating an electrically conductive filler. The electrically conductive filler provides a continuous electrically conductive path extending around and through the whole perimeter area of the frame 10.

Electrically conductive material 30A is selectively formed at the front opening of the frame 10 (as seen in FIGURE 11) to define an electrically conductive band extending around the periphery of the frame but limited to the edge and edge margins of the side walls 12,14 and of the end members 16,18 adjacent to the front opening of the frame 10A. Those edges and edge margins are initially treated by surface abrasion or chemical etching, if necessary, to ensure that the electrically conductive coating 30A makes reliable electrical connection with the conductive filler of the frame 10A. Suitably, the plastics material may comprise polycarbonate and the filler may, for example, be silver coated graphite or stainless steel. The conductive layer 30A may comprise a copper layer adherent to the plastics frame 10A and a nickel layer on the copper layer, both formed by electroless plating as previously described with reference to FIGURES 1-10, or by conductive paint or vacuum deposition, e.g. of aluminum.

However, by using a plastics material incorporating an electrically conductive material such that the molded frame incorporates an integral, electrically conductive peripheral surface over the frame 10A, it may be possible to dispense with a separate electrically conductive surface coating corresponding to the surface coating 30 as described with reference to FIGURES 1-10. The functional modules would then be connected by RF shielding gaskets directly to the integral, conductive surface of the frame 10A.

In some instances, it may be adequate to form the

electrically conductive coating 30A only on the edge walls and either the interior or the exterior edge margins of the side walls 12,14 and of the end members 16,18. It may even be sufficient to form the coating 30A only on the interior or the exterior edge margins and not on the edges of the side walls 12,14 and of the end members 16,18.

Still further, instead of forming one or more electrically conductive bands at the edges and/or edge margins of the frame 10a, an electrically conductive band of limited width could be formed on the side walls 12,14 and the end members 16,18 but displaced from those edges. The band would thus extend around the whole periphery of the frame but occupy only a part of the surfaces of the side walls 12,14 and the end members 16,18 between the front and back openings of the frame 10A. In any of the these alternative structures, functional modules FM, power supply units and closure strips CS and closure panels CP would be accommodated in the frame generally in the manner previously described with reference to FIGURE 9. However, the RF shielding gaskets would be positioned to provide electrical contact, and hence EMI/RFI leakage attenuation, at the interfaces between the conductive panels 54 and 62 and the electrically conductive band 30A, wherever it is located.

Alternatively, if the conductive filler can be sufficiently exposed by the surface abrasion or chemical etching step previously referred to in reference to FIGURE 11, the RF shielding gasket may then be directly brought into contact with the exposed filler, thereby eliminating the need to provide a separately applied conductive band 30A.

Although exemplary embodiments of the invention have been described, it is to be understood that other embodiments are contemplated within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A structural support member for housing electrical components in use and providing shielding therefor, comprising oppositely disposed edge walls joined by side walls and opposed end members to form a physically continuous, single-piece support frame having opposed end openings bounded by said edge walls, said end members having through walls defining spaced apart apertures in each said end member, said end members and said side walls having a continuous electricallly conductive path extending around substantially the whole perimeter area of said frame, and said electrical path including an electrically conductive, peripheral surface band extending over at least part of a surface area of each of said end members and said side walls.

2. A structural support member according to Claim 1, wherein said support frame comprises a plastics-based material, wherein said continuous electrically conductive path and said peripheral surface band are defined by a common, continuous coating of electrically conductive material over all surface areas of said side walls and said end members and surfaces of said through walls.

3. A structural support member according to Claim 1, wherein said frame comprises an electrically conductive plastics material incorporating an electrically conductive filler material.

4. A structural support member according to Claim 3, wherein said electrically conductive band comprises an electrically conductive surface coating electrically connected to said electrically conductive filler material, wherein said electrically conductive band is a continuous band extending continuously around the perimeter of said frame but occupying only part of the surface area of said frame.

5. A structural support member according to Claim 4, wherein said continuous band is located adjacent at least a margin area of said end members and said side walls adjacent to one of said end openings.

6. A single wall structural frame having physically continuous peripheral walls;

at least two of said peripheral walls spaced apart and each having a multiplicity of apertures defined by through walls; and

said peripheral walls comprising polymeric based structural support material having a continuous coating of

electrically conductive material over the surface areas of the peripheral walls including the through walls.

7. A structural frame according to Claim 6, wherein said continuous coating of electrically conductive material is an electromagnetic radiation shield.

8. A structural frame according to Claim 7, wherein said at least two peripheral walls are disposed in generally opposed relation to each other and said multiplicity of openings provide fluid flow registers, wherein said multiplicity of openings is an ordered array of openings.

9. A structural frame according to Claim 6, wherein said polymeric based material is a foamed material wherein said polymeric material comprises about 10 to 30% filler material providing structural stability to said peripheral walls.

10. A structural frame according to Claim 9, wherein said electromagnetic radiation shield provides radiation attenuation at frequencies in the gigahertz range, wherein said electrically conductive material comprises a first layer bonded to said polymeric based material and a second layer bonded to said first layer.

11. A structural frame according to Claim 10, wherein said

first and second layers comprise copper and nickel respectively.

12. A structural frame as in claim 7, including at least one shelf member within said structural frame extending between a second opposite pair of said peripheral walls, said shelf member defining tracks for receiving circuit modules between said shelf and respective ones of said first pair of opposite pair of peripheral walls.

13. A structural frame according to Claim 12, including a plurality of circuit modules located in said tracks, each said circuit module including an electrically conductive end-panel having a periphery in electrical contact conductive end-panels of adjacent modules and with said coatings of electrically conductive material on said peripheral walls and said shelf margins along substantially the whole of said periphery, including conductive RF shielding gaskets establishing said electrical contact.

14. A structural frame according to Claim 13, wherein said RF shielding gaskets comprise electrically continuous strips of resilient contact fingers.

15. A structural frame according to Claim 13, including an electrically conductive closure shield over the other one of said end openings of the rectangular frame, said shield

having a perimeter in substantially continuous electrical contact with said electrically conductive coating, wherein said closure shield comprises a metal plate secured to said frame and an annular RF sealing gasket compressed between said metal plate and said electrically conductive coating.

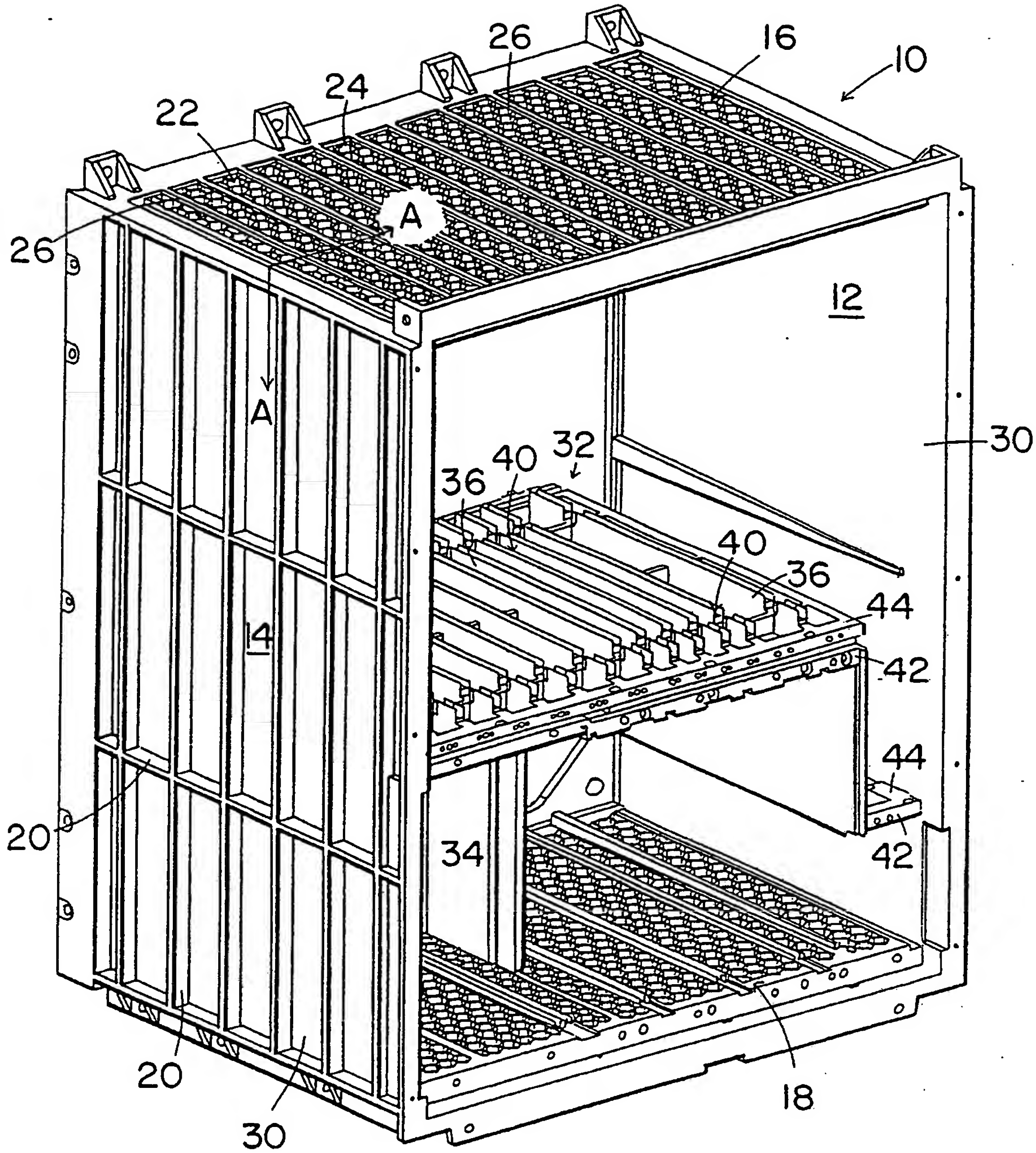


FIG. 1

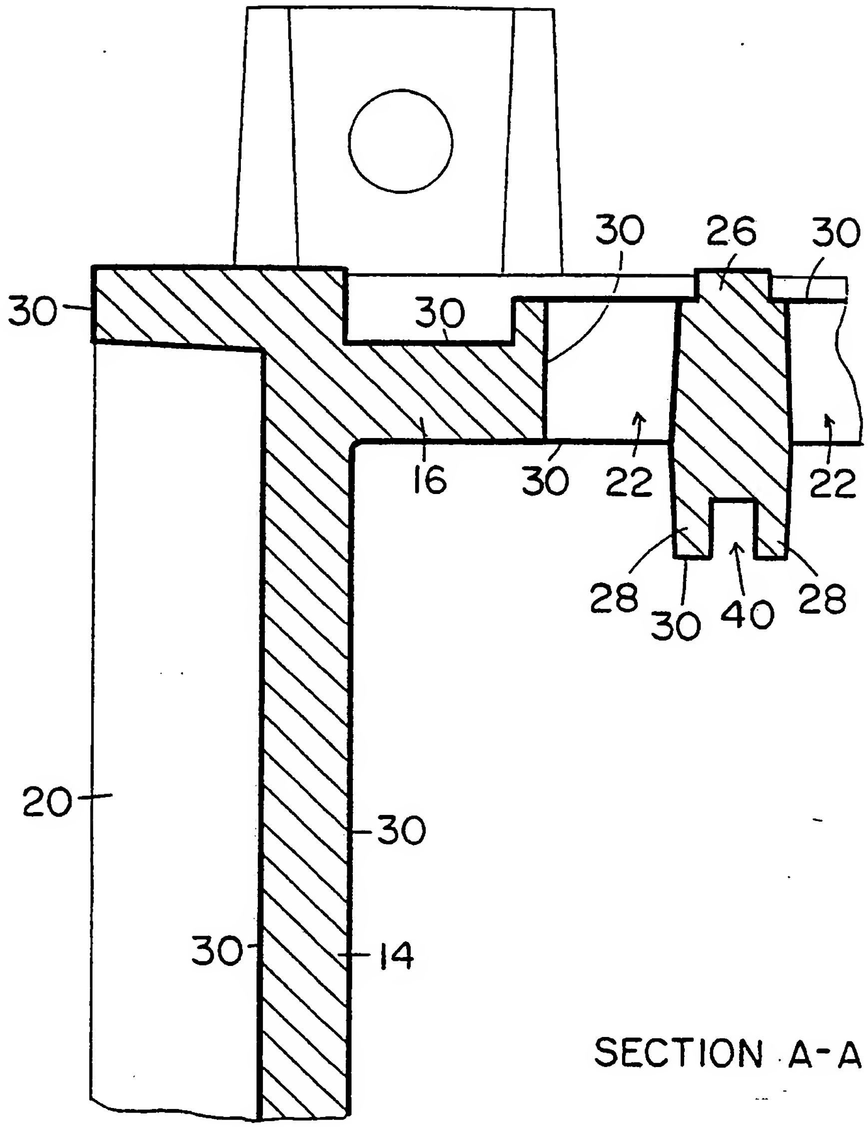


FIG.2

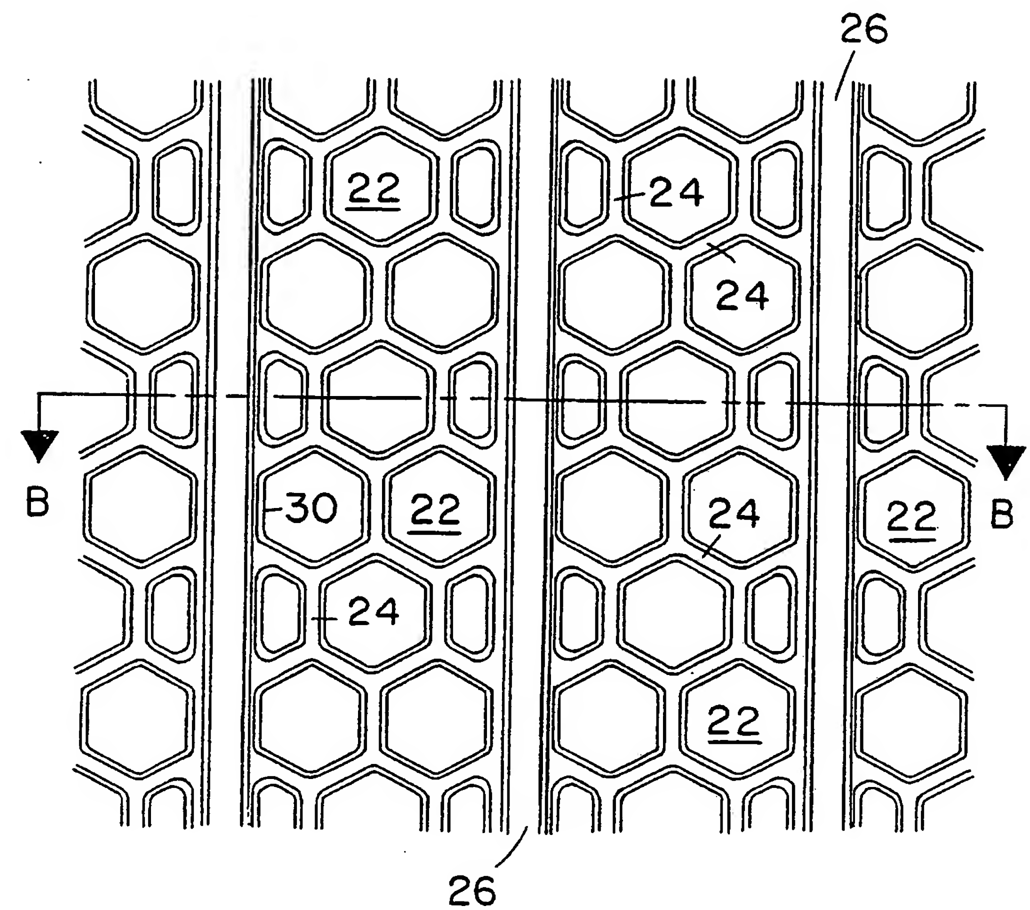
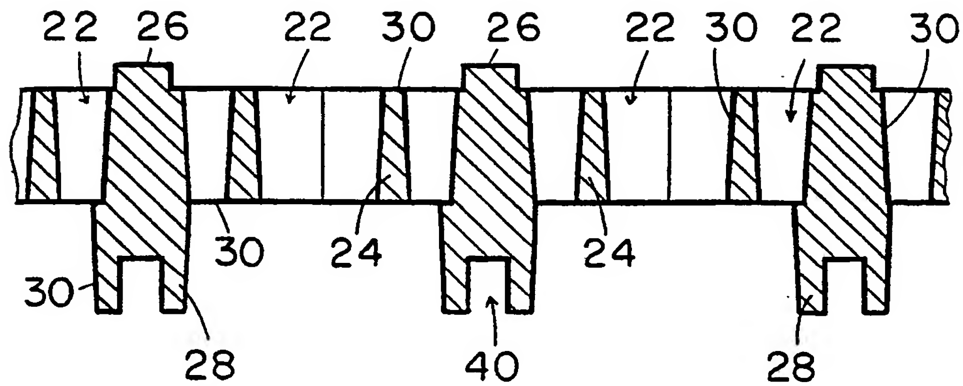


FIG. 3



SECTION B-B

FIG. 4

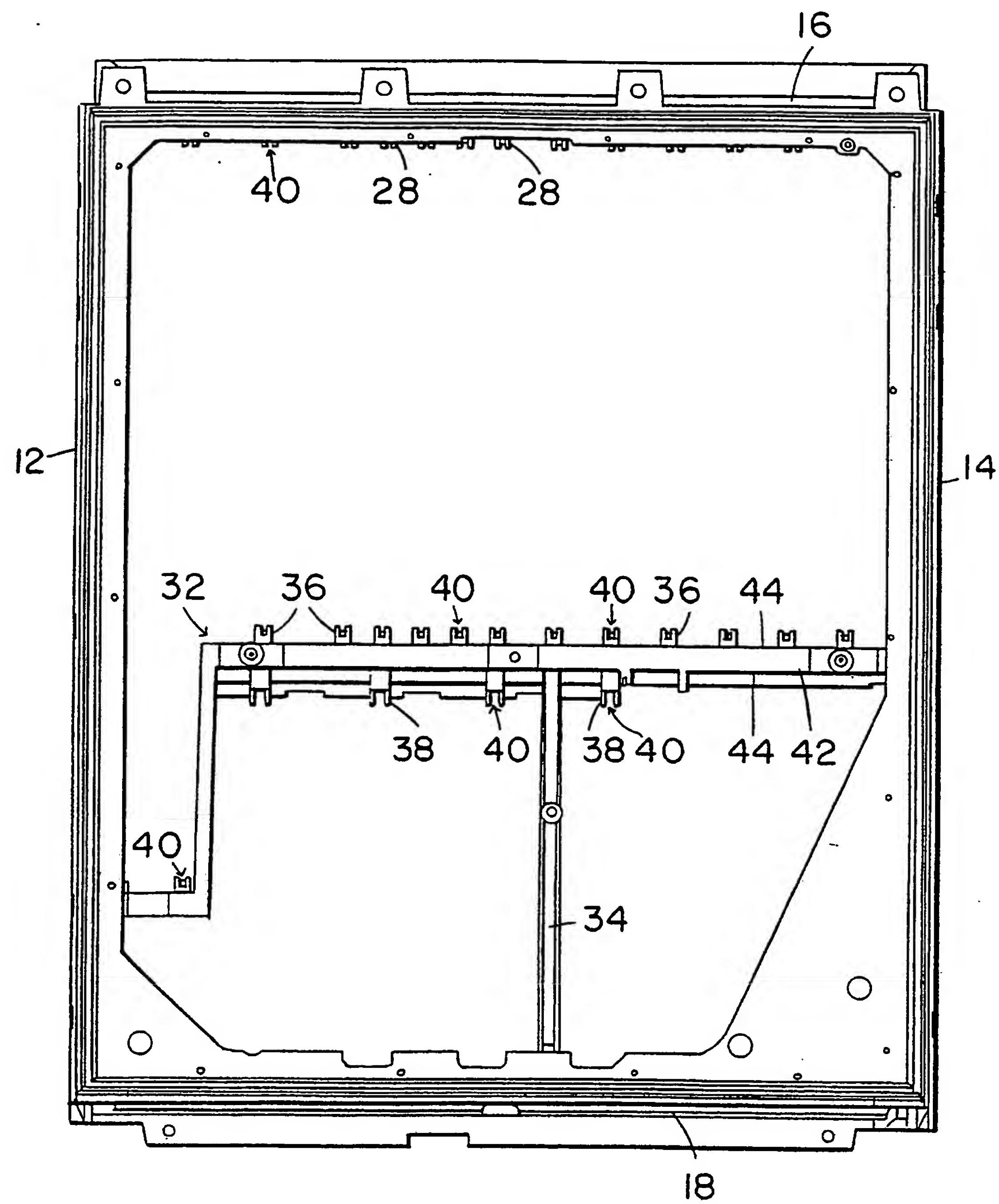


FIG. 5

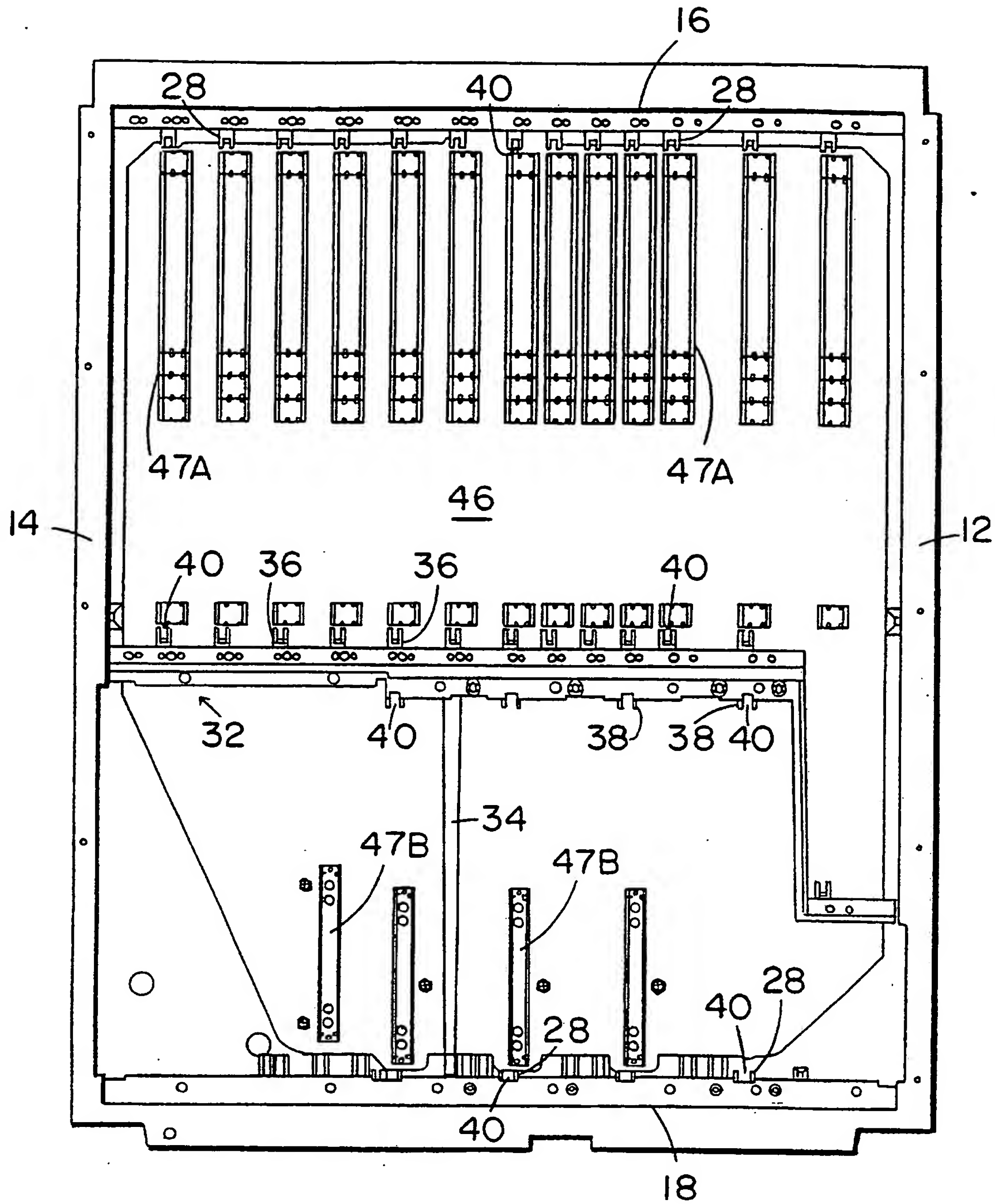

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FIG. 6

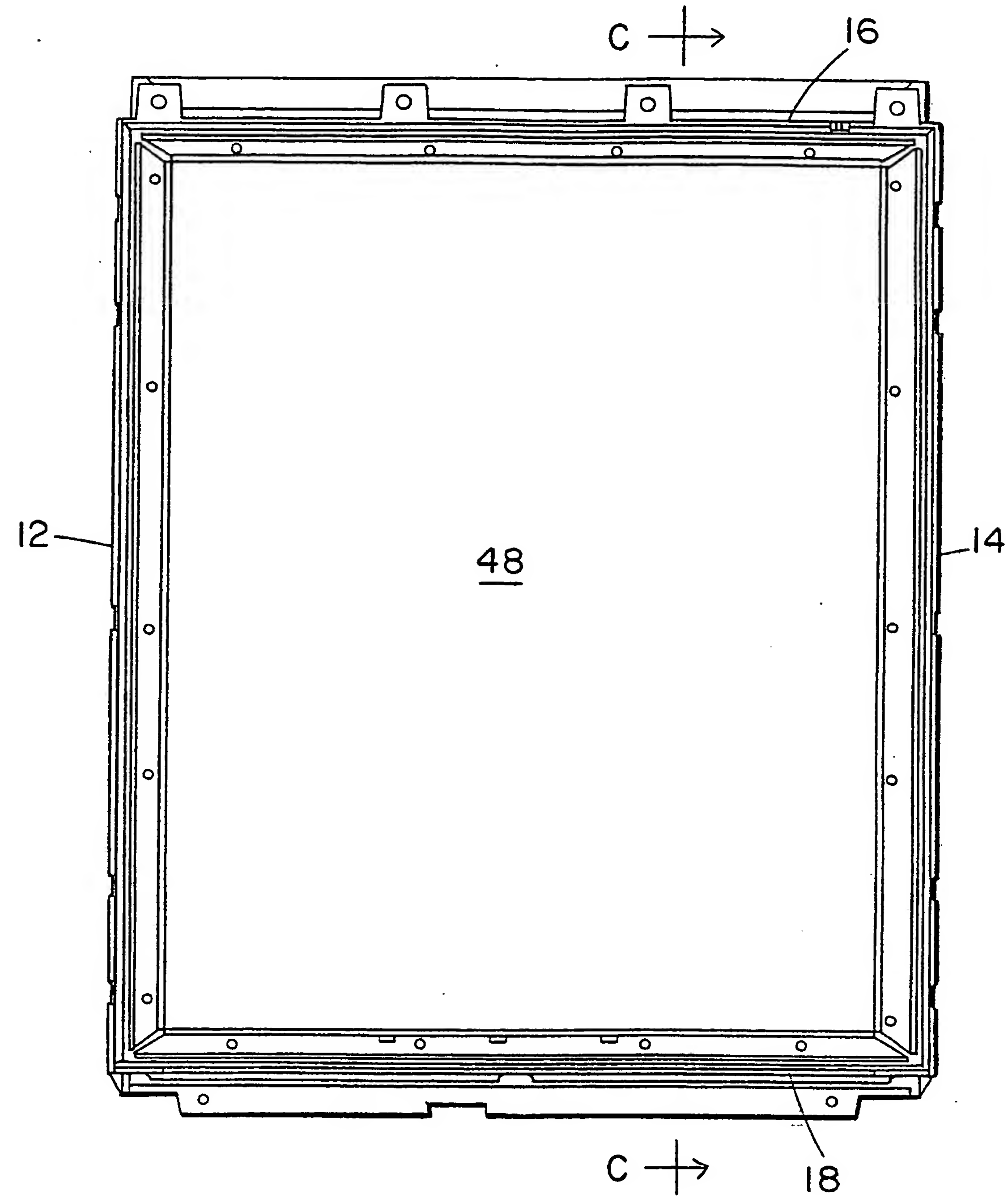


FIG. 7

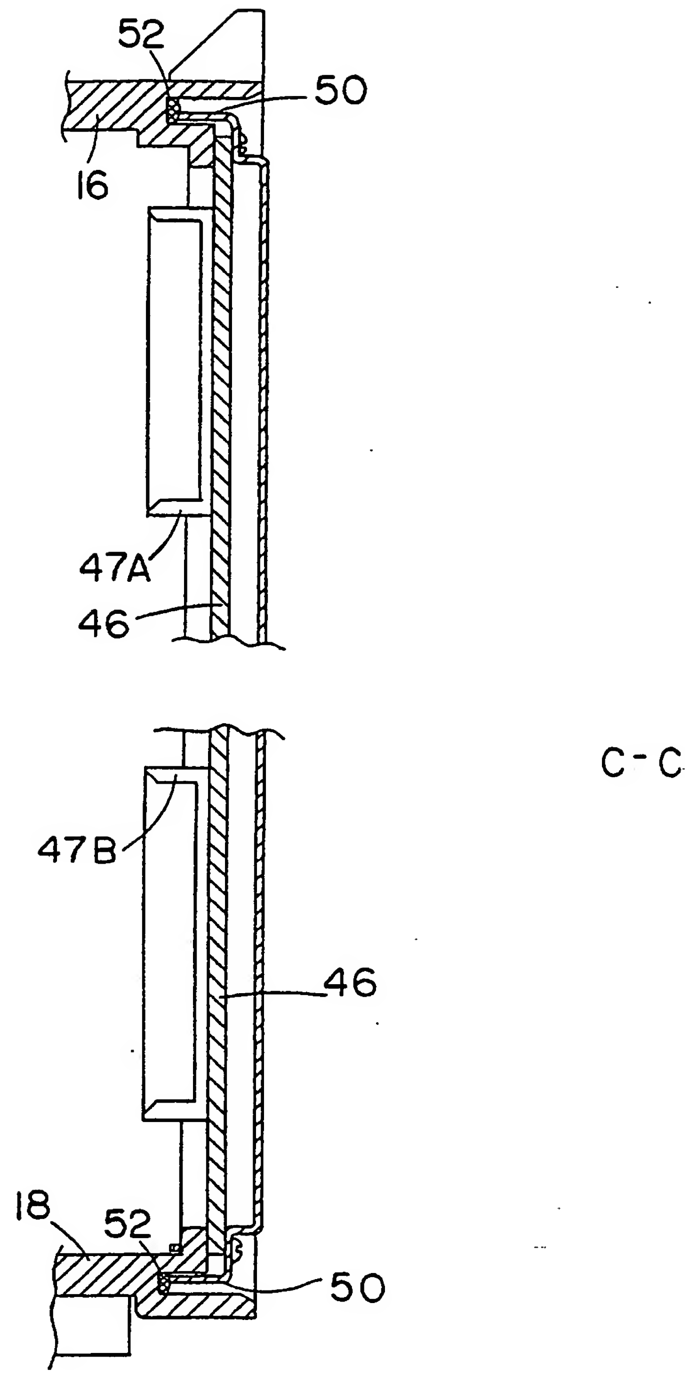
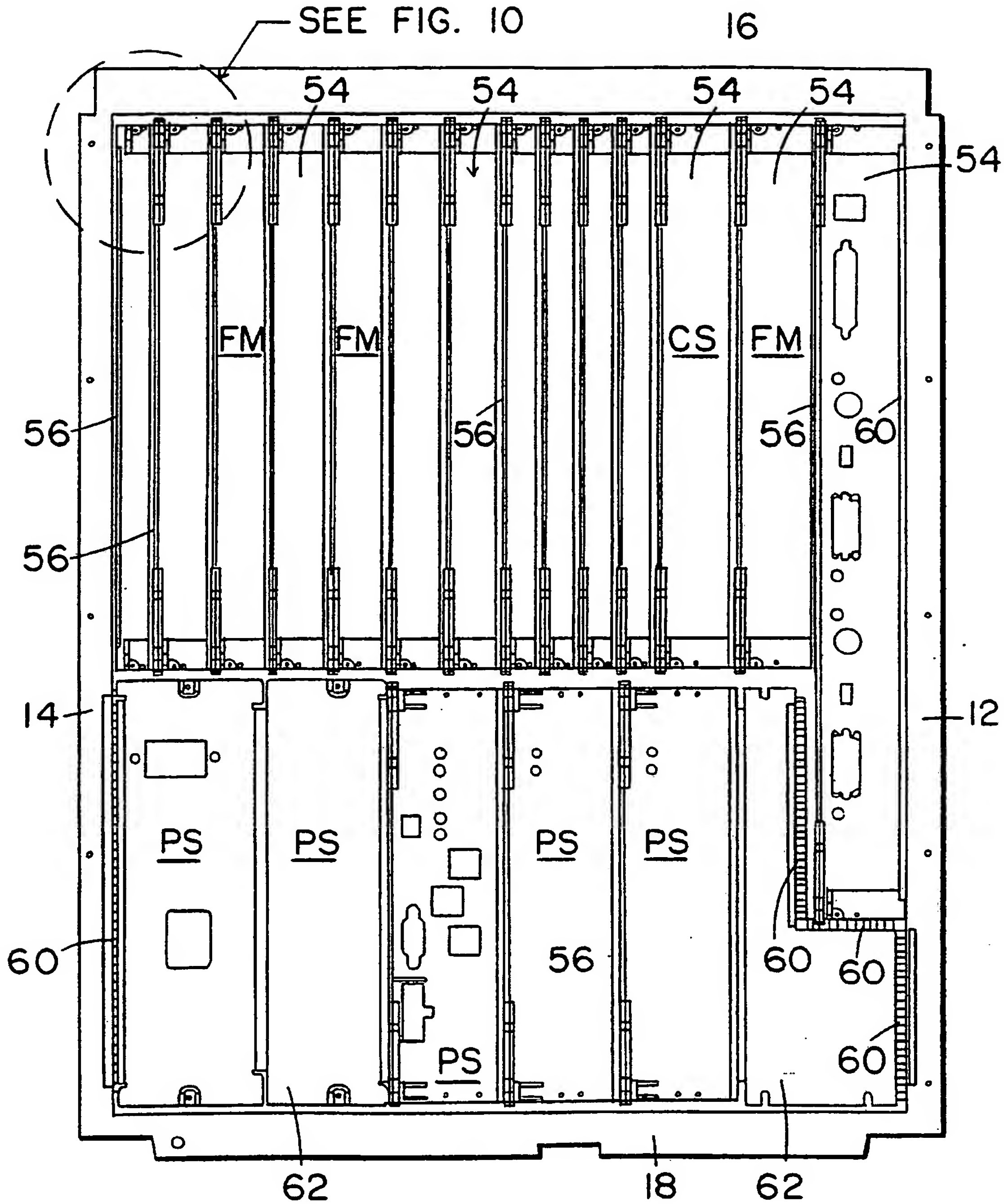


FIG. 8


SEE FIG. 10
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FM
FM
CS
FM
56
56
56
56
60
14
12
PS
PS
PS
PS
PS
60
56
60
60
60
62
18
62

FIG. 9

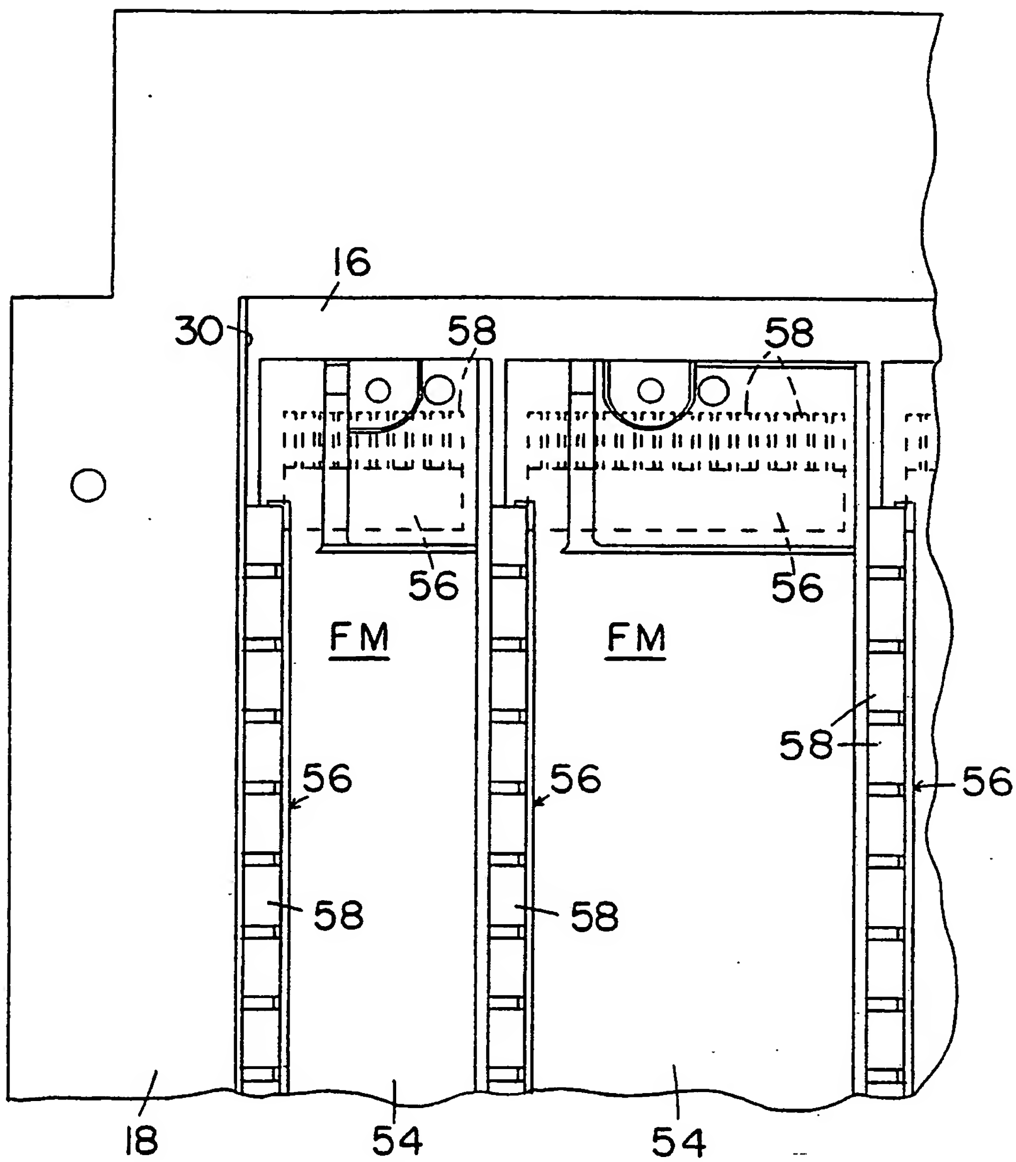

FIG. 10

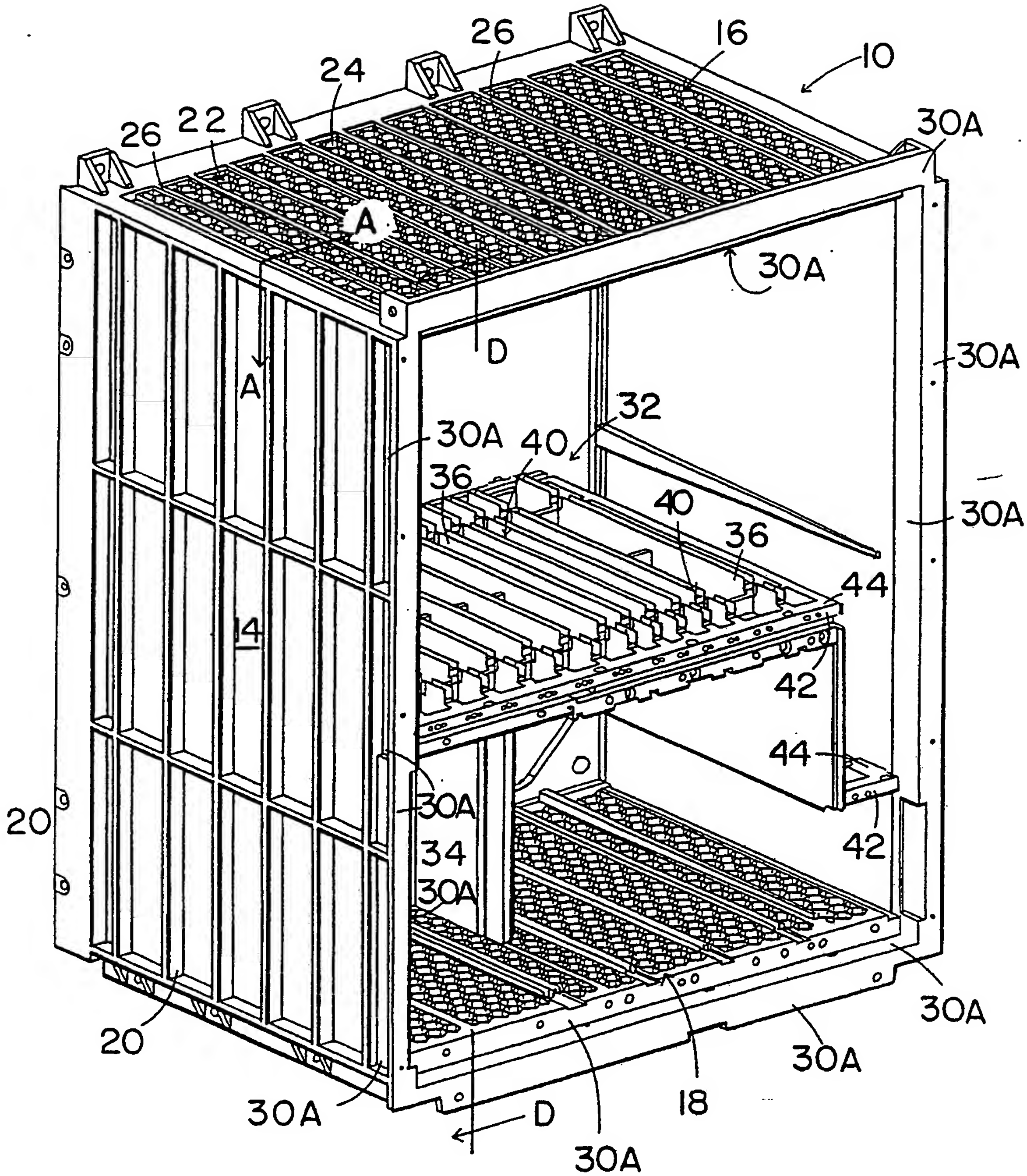
26
16
10
24
22
26
30A
A
30A
D
30A
A
32
30A
40
36
40
30A
36
44
14
42
44
20
30A
34
42
30A
20
30A
30A
30A
18
D
30A

FIG. 11

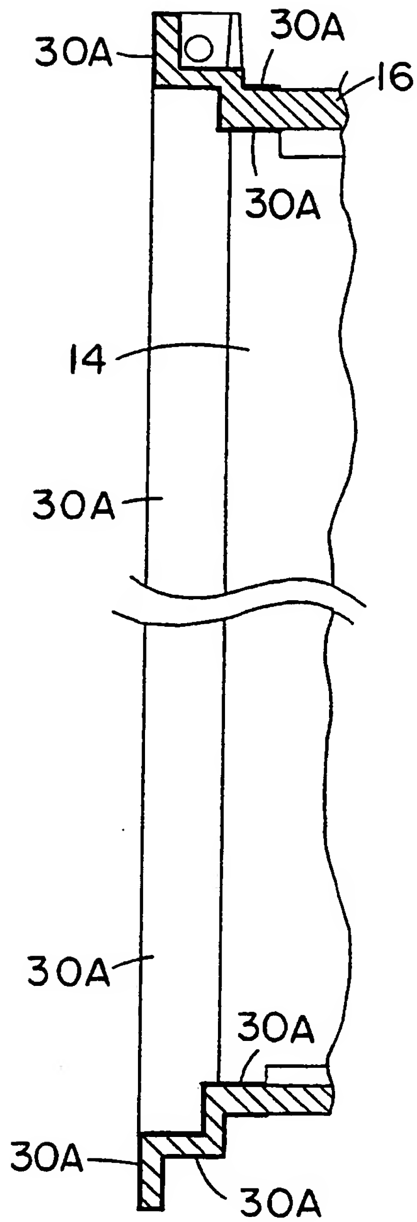

FIG. 12

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 93/01236

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H05K7/14; H05K9/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H05K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	US,A,4 509 647 (SHEVCHUK) 9 April 1985 see the whole document ---	1-3,6-8
Y	NTIS TECH NOTES July 1991, SPRINGFIELD, VA US page 537 NOSC 'ELECTRONIC ENCLOSURE IMPROVED' see the whole document ---	1-3,6-8
A	FR,A,2 535 932 (COMPAGNIE GENERALE DE CONSTRUCTIONS TELEPHONIQUES) 11 May 1984 see the whole document ---	1,6
A	DE,U,8 901 676 (KLOECKNER-MOELLER) 13 June 1990 see the whole document ---	4,9
	-/--	

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

1

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19 MAY 1993	04. 06. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	TOUSSAINT F.M.A.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 563 722 (MARONEY ET AL.) 7 January 1986 see the whole document -----	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

US 9301236
SA 70565

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 19/05/93

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4509647	09-04-85	None		
FR-A-2535932	11-05-84	None		
DE-U-8901676	13-06-90	None		
US-A-4563722	07-01-86	AU-B-	574822	14-07-88
		AU-A-	4608185	24-03-86
		CA-A-	1231750	19-01-88
		EP-A,B	0193540	10-09-86
		WO-A-	8601673	13-03-86

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82